After dinner we entered the wooded valley and began our search. Almost in the edge of the water near our stopping-place rank stems of *Glyceria arundinacea* Kunth., three feet high, and with a panicle about sixteen inches long, were gathered. This is not a rare species in many places, but has not been noted before for Nebraska. Near this, and still in the edge of the water, were *Glyceria nervata* Trin., and the common *Panicum virgatum* L. The trees commonly found growing in the valley were *Celtis occidentalis* L., *Prunus americana* Marshall, *Prunus demissa* Walpers, *Ulmus americana* (L.) Willd., *Cornus stolonifer* Michx., *Negundo aceroides* Mœnch., *Populus monolifera* Ait., *Salix longifolia* Muhl., *Rhus glabra* L., and in isolated patches or clumps *Shepherdia argentea* Nutt. The latter is found also on the edge of the bluffs above.

In the woods specimens of *Elymus striatus* Willd., *Agrostis exerata* Trin., and *Impatiens pallida* Nutt., were collected. The latter was very badly rusted (*Æcidium impatientis* Schw.). The rather rare grass *Oryzopsis micrantha* (Trin. and Rupr.), never before catalogued for Nebraska, grew in the edge of a pond, and near it, on wet, sandy soil, *Alopecurus geniculatus* L. var. aristulatus (Michx.) Torr.

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[To be Continued.]

ZOÖLOGY.

Professor H. Gadow on the Homologies of the Auditory Ossicles.—The homology of the auditory ossicles does not seem to be yet settled. The last contribution to the subject is that of Herr Hans Gadow, now Strickland curator and lecturer on the advanced morphology of the Vertebrata, at Cambridge, England. (Philo. Trans. Royal Society, London, 1888, Vol. 179, pp. 451–485.) Professor Gadow carries the history of the first and second visceral arches through the entire vertebrate series, and illustrates his memoir with four quarto plates, which give the results of his labors. The possession of an ample collection of rare Elasmobranch forms, especially Heptanchus, Hexanchus, Centrophorus, Myliobates, and Trygon, with several fresh examples of Sphenodon, motived the examination of the question. Professor Gadow finds that in the Notidanidæ the first and second

arches do not articulate with each other, but that in all remaining Elasmobranches there is a suspensorial arrangement. In Centrophorus, Mustelus, and Acanthia there is no direct contact of the two arches; in Oxyrhinia and Sphyrna the hyoid and mandible have developed articular facets for contact, whilst the hyomandibular does not; but in Galeus, Scymnus, Cestracion, and Trygon the hyomandibular and mandible are in contact. In Trygon the former is also in contact with the quadrate portion of the first arch.

The Dipnoan and Batrachian series show the gradual and finally absolute estrangement of the hyomandibular-hyoid arch from the palato-quadrato-mandibular arch, leading to the loss of ligamentary connection, and to the final attachment of the hyoid to the cranium. The hyoid becomes completely separated from the hyomandibular, which would have aborted completely had it not assumed new—namely auditory—functions, by becoming connected with a tympanum, *i.e.*, a cavity formed out of the first visceral cleft. The hyomandibular, invested with this new function, breaks up into two or more pieces, as an ossicular chain. The old piscine ligamentous, or even cartilaginous, connection between hyomandibular and mandible is lost in the Salientia, and in the Urodela a piece of cartilage, comparable either with a symplectic or an opercular element, is also gradually lost. The tympanal end of the auditory chain or rod becomes connected with the cranium by a suprastapedial element, probably of periotic origin, while the quadrate becomes reduced to a small cartilage wedged between the elongated pterygoid and squamosal. This elongation of the pterygoquadrate bar, transposing the masticatory joint outwards, away from the cranium, has caused, or at least facilitated, the separation of the hyoid from the hyomandibular. In the Chelonia the broad quadrate is fused with the skull. In the Trionychidæ and land tortoises (as shown by Peters) the quadrate forms a closed canal through which passes the columellar rod, but in other tortoises and turtles it forms an imperfect canal, open behind and below. In all chelonians the interfenestral apparatus consists of two pieces, and the hyoid is frequently either absent or is a mere bit of bone or cartilage attached to the basilingual plate. The pair of long bony bars which act as hyoid is really the third visceral or first branchial arch. In the Crocodilia the auditory apparatus is very complex. The air cavities of the os articulare are connected with the middle ear or tympanic cavity by the fibrous and partly cartilaginous siphonium. The air-cavities of the quadrate are also in direct communication with the tympanic cavity. The outer end of the columella proper possesses a concave facet, by

which it articulates with the short basal stem of a trifid extra columellar cartilage or malleus. The lower process of this trifid malleus is connected with the mandible by a cartilaginous or partly ligamentous string, for the reception of which the quadrate forms a bony canal.

The whole string is originally cartilaginous. The hyoid arch has entirely disappeared as far as ceratohyal and stylohyal pieces are concerned.

In Sphenodonia the top end of the hyoid is fused with the extracolumella. In Gecko it is attached to the cranium, as in the Mammalia, but in most lizards the proximal portion of the hyoid is removed from the skull, and remains otherwise well developed. In the Ophidia and in birds, as in Crocodilia and Chelonia, the proximal part of the hyoid becomes reduced and lost. In Ophidia and in Chamæleo the extracolumella gains an attachment to the quadrate, squamosal or pterygoid, while its connection with the mandible and the tympanum is lost. The chamæleon has no tympanum, and those parts of the extracolumella which in other types would be attached to the tympanum, are here attached to and fused with the quadrate. In birds the arrangement of the auditory ossicular apparatus is very similar to that of the monitors. In the adult the whole hyoid bar is absent, with the exception of a small cartilage.

In mammals, as is well-known, the ossicles of the ear are usually four, although the small lenticular element which lies between stapes and incus frequently remains cartilaginous, and is occasionally absent. The hyoid has no connection with either mandible, palate, quadrate, or with the ossicular chain, but its upper end is fused with the cranium behind the tympanic ring. Many various views have been held respecting the origin of the auditory ossicles. Tindemann (1810) held that the entire ossicular chain of mammalia was equivalent to the columella of birds and reptiles, and that the quadrate equals the zygomatic process of the squamosal. Reichert (1837) derived the malleus from the articular element of the mandible, the incus from the quadrate, and the stapes from the end of the hyoid. Gegebaur agreed with Reichert as regards the malleus and incus, but derived the lenticulars and the stapes respectively from the symplectic and the hyomandibula. Peters (1867) held that all the ossicles were developed from Meckel's cartilage, and that the quadrate had become the tympanic bone. Huxley (1867) and Parker both held that the quadrate of birds and reptiles became the malleus of mammals, and that the incus and lenticular were derived from the hyomandibula. Huxley also held that the stapes is of hyomandibular origin, but Parker was inclined

to derive this element from the auditory capsule. Parker's later view derived the malleus from the articulare, and the incus from the quadrate. Salensky (1880) held that the malleus and incus came from Meckel's cartilage; Fraser (1882) derived the malleus from the end of the mandibular cartilage, and the incus from the proximal end of the hyoid, whilst Albrecht (1883) traced all the ossicles to the hyomandibular, and held that the quadrate was present as the zygomatic process of the squamosal. Gradenigo (1887) agrees with Salensky with regard to the malleus and incus, but derives the stapes from the hyomandibular and periotic cartilage.

Prof. Gadow agrees with Peters in making the quadrate bone equal to the tympanic bone of the mammals, and states that no animal possesses both an os tympanicum and a distinct quadrate bone. The Salientia have indeed a tympanic ring, which Prof. Gadow, on Balfour's authority, derives from the metapterygoid region of the quadrate. He agrees with Albrecht in deriving the ossicles of the middle ear from the hyomandibular element of the second visceral arch. This last speaker upon the vexed question of the homologies of the suspensorium and ear bones therefore supports Albrecht in the main points of his thesis, but differs in regarding the tympanic bone rather than the zygomatic process as the representative in the Mammalia of the sauropsidan quadrate.

Prof. Lankester on Amphioxus.—E. R. Lankester contributes to the *Quarterly Journal of the Microscopical Society* (April 29, 1889) a number of valuable particulars concerning the anatomy of the lancelet, with special reference to numerical characters. In the living animal the atrial chamber projects between the lateral ridges or metapleura. Between these metapleura the ventral wall is in the living animal plaited into longitudinal folds, six or eight upon each side of the middle line; but when the generative products are full grown these folds disappear. A large drawing taken from life shows these folds. There are not any canals below these ventral plaitings, as was believed by Stieda, Rolph, and others. *Branchiostoma lanceolatum*, the species found at Naples, has on an average 61 myotomes; *B. elongatum*, from Peru, has 79; *B. bassanum*, from Bass's Straits, has 75–76; *B. belcheri*, from Borneo, 64–65; *B. caribbæum*, from Rio de Janeiro, 59–60; and *B. cultellum* has 52. The full number of myotomes is acquired at a very early period of life, even before the epipleural chamber is complete. The true mouth is the small median aperture concealed by the oral hood, which latter is really a preoral portion of the epipleural folds.

Twelve delicate tentacles project from the mouth into the pharynx. The atriopore seems to coincide with the thirty-sixth myotome, the anus with the fifty-first. The formula would, therefore, be 36–15–10–= 61. The number of dorsal fin rays is 250–260, although there are none over the last six myotomes; there are thus about five to a myotome; but there does not seem to be any fixed relation between the two numbers, especially as the ventral fin rays are proportionately less numerous,—thirty-four or rather more in twelve myotomes. The fin rays lie in a compartmented lymph-space, which is antecedent to the rays and extends beyond them, both fore and aft. The cœlomic sacs, in which the reproductive cells develop, correspond to twenty-six myotomes. The pre-oral tentacles vary in number, but are always fewer in young examples. They are formed in pairs. After the larval phase is passed all relation is lost between the number of myotomes and that of the gill-slits, which latter numbered ninety-six in specimens a little under an inch in length, and one hundred and twenty-four in larger examples. Each primary gill-slit is borne upon a solid chitinous rod, and each becomes secondarily divided by the growth of a tongue in the direction of the length of the slit: these tongues are carried upon hollow chitinous rods.

The body contains three kinds of spaces, which are filled with lymph: (1) the atrial chamber, (2) the enteric spaces, (3)the hæmolymph cavities. An atrial cercum extends back to beyond the atriopore. The enteric cavity consists of atrium, intestine, and cæcum, the last given off as a diverticulum at the 28th or 29th myotome, and reaching forward to the 14th or 15th in adults. The vascular system seems to be in a state of degeneration. Certain of the vascular trunks are continuous with the lymph spaces, so that the vascular and lymphatic systems cannot be distinguished. The metapleural lymph canals disappear when the gonads are ripe, and it does not appear improbable that their lymph serves as a final supply of nutriment to the gonads.

Dr. Lankester has discovered two short, wide, brown funnels opposite to the 27th myotone; the wide end turned toward the atrium, the narrow directed to the dorso-pharyngeal cœlom, and thus serving to place the latter in communication with the former. Dr. Lankester's memoir is illustrated with five plates.

Note on Ammocoetes Branchialis (Linnæus).—Previous to the fall of 1885 we had no positive record of this species from localities other than from Central and Southern Indiana, and from Southern Wisconsin. On May 8, 1886, Professor S. A. Gage and

myself discovered several specimens of this species in Cayuga Lake Inlet, five of which we captured.

One year ago Professor F. Star informed me that they were seen by him in the spring, in large numbers, in the small streams tributary to the Cedar River, Iowa.

This spring I collected about sixty specimens in a small brook from two to five feet wide, near Cedar Rapids, and many others were seen, all in a distance of about three-fourths of a mile.

In 1886 we compared the five specimens from Cayuga Lake Inlet with as many more specimens from Indiana, noting only this difference: in the Inlet specimens the extreme mandibulary cusps were larger than the inner ones, while in the specimens from Indiana all the cusps were subequal.

Dr. B. G. Wilder has kindly sent me twenty specimens from Ithaca, N. Y. These I have carefully compared with the specimens collected near Cedar Rapids, and am convinced that all are of the same species.

In most of the specimens the outer mandibular cusps are larger than the four others. In other specimens the cusps are subequal. The usual number of cusps is six. Occasionally a specimen is found with seven cusps, and rarely one with five.

There is no crest developed on the back of either sex during the breeding season, as is so characteristic of *Petromyzon marinus.* About one-fifth distance from the vent to the end of the tail a small fin-like crest is developed on the male. There is also a similar crest on the female, which is larger, less firm, and more fin-like.

The dorsal fins on both males and females are situated on a small crest, which is more conspicuous on the males.

The number of muscular impressions between the last gill opening and the vent vary from sixty-five to sixty-eight.

A microscopical examination of the zoösperms shows those in both the specimens from Ithaca, N. Y., and Iowa, to be of apparently the same shape and size. The head is large and prismatic, with a long, slender tail, which usually has an enlargement near its posterior end. It is quite evident that this species is far more widely distributed in this country than was formerly supposed, and it will no doubt be found in all streams in the Mississippi Valley, at least north of the lower Ohio rivers.

Early in the spring they leave the larger streams, and ascend the smaller streams to deposit their eggs, which occupies from one to two weeks. They make their nests in the bed of the stream by excavating

cavities from two to five inches in depth, and with the diameter from one and a half to twice the length of the animal.

The places selected for these nests are in the bed of the stream, where the current is quite swift and the bottom is covered with gravel.

During the spawning time from one to six have been seen in the same nest. In the ordinary season they may be found spawning between the middle of April and the middle of May (May 8, 1886, at Ithaca, N. Y.; April 20, 1889, Cedar Rapids, Iowa).

The length of all the specimens I have examined from New York and Iowa is between five and six and a-quarter inches.—S. E. MEEK, *Coe College, Cedar Rapids, Iowa, May 22, 1889.*

Zoological News.—Development of Millepora.—Mr. S. J. Hickson, on his recent trip to the Celebes, had an opportunity to study the development of the coral *Millepora plicata.* His account will be found in the *Philosophical Transactions,* Vol. 179 B. This species is hermaphrodite. The eggs and spermatozoa arise in the ectoderm, but before maturity they break through the supporting layer and enter the entoderm. The spermatozoa wander into the dactylozoids and there form sperm sacks. The eggs, after a peculiar history, form two polar globules, after which they are fertilized. The nucleus now divides into numerous portions, each of which becomes surrounded by a mass of protoplasm, giving rise to a morula. The next stage is the formation of a solid blastosphere, followed by the development of cilia. In some cases there was an appearance like the beginning of invagination. Ten ciliated embryos escaped through the mouth of the gastrozoids.

Rotifera.—E. F. Weber, under the title of "Notes on some Rotifers," has communicated to the *Archives de Biologie,* Sept. 1888, an extensive description of the anatomy of some species of these short-lived creatures, and of the male and female characters.

Echinodermata.—H. Bury (*Quart. Journal Micros. Soc.,* Apr. 1889), puts on record a number of facts in the embryology of that stage of the echinoderm larva which has been named the Dipleurula, with special reference to the development of the enterocœls and hydrocœls in the different orders. From his observations it appears that the Ophiurid Dipleurula develops two pairs of enterocœls metamerically arranged, and that the hydrocœl is formed later, evidently from the posterior enterocœl. The echinid larva develops two pairs of enterocœls and a waterpore as in the ophiceran, but the hydrocœl seems to arise from the anterior enterocœl, and retains connection with it. In the Asterid Dipleurula anterior and posterior enterocœls may

be distinguished, but they are usually not separate, and the hydrocœl remains opens to the anterior enterocœl.

The crinoid Dipleurula develops only one anterior enterocœl, with which the hydrocœl is at first connected, but afterwards becomes separate. There are two posterior enterocœls. In the Holothurioidea there is no right anterior enterocœl, and the left is rudimentary; the hydrocœl, which is always on the left side, being connected with it. There are two posterior enterocœls.

The last portion of the paper treats of the development of the skeleton during this bilateral stage; it appears that many skeletal elements have their origin during this period.

Mollusca.—Paul Pelseneer has contributed to the *Archives de Biologie*, a dissertation upon the morphological value of the arms of the cephalopoda, and arrives at conclusions which differ widely from those most generally received. The problem to be solved is whether the arms are of pedal or cephalic origin,—whether they are or are not essentially appendages of the head. He endeavors to answer this question by an examination of the nervous system, which he illustrates in two plates. From this examination he deduces that the comparative anatomy of the nerves is contrary to the cerebral origin of the brachial ganglia, and in favor of their pedal nature. From a comparison of a walking gastropod with a walking cephalopod, it is evident that the arms of the latter stand in precisely the same relation to its head as does the foot of the former to its head. The only difference is that in the cephalopod adult some of the arms have assumed a position in advance of the mouth. But in the cephalopod embryo the mouth opens dorsally as in the gastropod, and is in advance of the arms. The entire vitelline sac was, according to Pelseneer, taken for the foot by Balfour and by Brooks, but the margins of the foot persist around this vitelline sac, and the arms represent the margins of almost all the foot. The swimming-lobes of Pteropoda and the Aplysiidæ correspond to the lateral borders of the foot in the gastropod, and may thus be compared with the arms of the Cephalopoda. Thus these arms are not merely the propodium, but represent the margin of almost the whole gastropod foot. The siphon (entonnoir) is the epipodium.

C. R. Keyes gives an annotated catalogue of the Mollusca of Iowa, in the Bulletin of the Essex Institute, Vol. XX., in which he enumerates 151 species now existing, and thirty-two from the loess of the state.

Arthropoda.—M. Nussbaum has seen two polar globules in the cirripede egg (*Zool. Anzeiger, 301*). The first is formed while the egg is in the ovary, the second after fertilization in the egg sac.

Vertebrata.—Dr. R. W. Shufeldt publishes (*Journal Comp. Med. and Surg.*, Apr. 1889), an account of the osteology of the hawk, *Circus hudsonius*.

Mr. S. Garman (Bulletin Essex Institute, XX.), has collated the references to the Batrachia in the various editions of Kalm's Travels in North America. The result is to overturn some of the nomenclature of our frogs and toads.

EMBRYOLOGY.

Homologues in Embryo Hemiptera of the Appendages to the First Abdominal Segment of other Insect Embryos. —While preparing a paper on the appendages of the first abdominal segment of the embryo *Blatta germanica* for the Proceedings of the Wisconsin Academy of Sciences, Arts and Letters, to be published during the coming summer, my attention was drawn to the Hemiptera, on which no observations have as yet been made in regard to appendages to the first abdominal segment. The pair of appendages which appear on this segment in embryo Orthoptera, Coleoptera and Trichoptera remain short, but become bulbous, and persist in some cases till the larva hatches. All investigators agree that in these three orders the curious appendages reach their greatest development during the revolution of the embryo. They have been regarded by Rathke, Ayers, and Graber as embryonic gills, by Patten and myself as glands.

The two species examined by me were *Cicada septemdecim* and *Nepa cinerea*, which represent two of the three large divisions of the Hemiptera.

In both cases the appendages persist as in the Orthoptera till after revolution, but instead of being *e*vaginated as in the insect embryos heretofore investigated, they are *in*vaginated. The shape of one of these appendages is bulbous, and its pyramidal cells are radially arranged with their broader basal ends turned inwards and their tapering outer ends terminating on the surface of the body. In *Cicada* there are few cells in the organ, in *Nepa* a much greater number.

In *Cicada* a glairy, much vacuolated mass is secreted by the tapering outer ends of the cells, and projects into the space between the body